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AIRBORNE GEOPHYSICAL AND TECTONICS OF THE CEARÁ CENTRAL DOMAIN, EASTERN REGION OF THE SANTA QUITÉRIA MAGMATIC ARC, BORBOREMA PROVINCE, NE BRAZIL

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ABSTRACT. The airborne geophysical data gamma-spectrometric and magnetic from Itatira Project (1977) was carried out, in the central region of the State of the Ceará, Brazil. Their processing produced products useful to indirectly identify regional geologic features. The verification and applicability of this approach was tested in a pilot-area whose limits are within the Umirim and Canindé topographic sheets, at 1:100,000 scale. The integration between the airborne geophysical and the geologic field data supported to the geologic mapping at the same cited scale. Two main units were recognized: the Santa Quitéria magmatic arc and the supracrustal sequences that surround the arc. The rocks from Santa Quitéria magmatic arc are characterized by high counting on the K-channel in its almost entire region and intermediate and low counting of eTh and eU. Generally, the supracrustal sequences are characterized by high values on the eU-and-eTh-channels and low on K-channel. The subunit metaultramafics and, mafics granulites, are remarkable by the occurrence retrograde eclogites bands and mafic granulites as lenses within gneisses and migmatites. These subunits present strong negative anomalies, with low counting on the three K, eTh and eU channels. That area also has positive magnetic anomalies, and may reflect high values of magnetic susceptibility.

Keywords: airborne geophysical, geologic mapping, mafics granulites, retrograde eclogites.

RESUMO. Dados aerogeofísicos gamaespectrométricos e magnéticos adquiridos no Projeto Itatira (1977), região central do Estado do Ceará, foram processados e integrados com a finalidade de gerar produtos que possam ser utilizados como ferramenta indireta na identificação de feições geológicas regionais. A verificação e aplicabilidade do método foram postas em prática na área piloto compreendida pelas folhas topográficas 1:100.000 Umirim e Canindé. A integração dos dados aerogeofísicos e geológicos de campo, dando suporte ao mapeamento geológico em escala 1:100.000, permitiu reconhecer duas principais unidades de mapeamento: o arco magmático de Santa Quitéria e as seqüências supracrustais que o bordejam. As rochas do arco magmático de Santa Quitéria foram caracterizadas por apresentarem altas contagens no canal de K em quase toda região de abrangência e contagens intermediárias e baixas de Th e U. De modo geral, a seqüência supracrustal foi caracterizada por apresentar alta contribuição dos canais de U e Th e baixa de K. As subunidades metaultramáficas e granulitos máficos, onde se destaca a ocorrência de retro-eclogitos e granulitos máficos encaixados como lentes em gnaisses e migmatitos, apresentam baixas contagens nos três canais K-eTh-eU. Na magnetometria essas rochas têm anomalias positivas e devem refletir altos valores de susceptibilidade magnética.

Palavras-chave: aerogeofísica, mapeamento geológico, granulitos máficos, retro-eclogitos.

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INTRODUCTION

The advance of the airborne geophysical data processing technologies and the integration with geological data allow to recover useful and valuable information from geophysical surveys carried out with older techniques. This information (rock types, structures) represents an essential tool to conventional geologic mapping and characterization of the tectonic evolution of Precambrian terrains, where the stratigraphic and structural relations are usually obliterated by later deformational events or hidden by unconsolidated sediments.

In the northwestern and central region of the Ceará State the aeromagnetic and aerogamma-spectrometric data Itatira Project (CPRM, 1977) were obtained by means of 500 m-spaced N-S flight lines and perpendicular (E-W) 20 km-spaced control lines. A high-density sampling results from this type of setting. After data treatment, the identification of a series of gamma-spectrometric and magnetic features was possible, which correlated well with regional and local litho-structural features.

The northwestern portion of the Borborema Province has attracted several researchers who developed geologic, geochronologic and geotechnological studies in the area (Castro, 2004; Teixeira, 2005; Amaral, 2007; Arthaud, 2007). The Borborema Province is considered to be part of a Neoproterozoic, Brasiliano/Panafrican orogenic system that resulted from the convergence of the Western African/São Luiz, Amazonian and São Francisco/Congo cratons.

In the Ceará Central Domain, located in the Ceará central region between the Senador Pompeu and Transbrasiliano lineaments, were described in the Itatira region the occurrence of clinopyroxene- and garnet-bearing amphibolites is evidence of high-pressure metamorphism, possibly under eclogite-facies conditions (Castro, 2004; Garcia & Arthaud, 2004).

These rocks usually occur as small bodies elongated and boudinaged along the regional trend. In the African counterpart of the Ceará Central Domain, in Togo and Western Nigeria, similar rocks delimit the suture zone that resulted from the closing of the Pharusian Ocean (Attoh, 1998; Caby, 2003; Santos et al., 2008; Arthaud et al., 2008). The role played by these rocks in the Western Gondwana supercontinent amalgamation is still not well understood, due to the major individualization of these bodies in Central Ceará Domain and the lack of geochemical data that could define the environment of its formation and/or the protolith.

From the tectonic point of view, the Ceará Central Domain constitutes one of the most important and the least understood terrain of the Borborema Province. This domain is also marked by the occurrence of high-pressure metabasic rocks hosted in paragneisses and migmatites in both eastern (Castro, 2004; Garcia & Arthaud, 2004) and western (Santos et al., 2008) side of the Santa Quitéria magmatic arc.

Thus, the proposal of this work is the integration of aeromagnetic and aerogamma-spectrometric data of the Itatira Project and field work in the Canindé and Umirim 1:100,000 sheets, in order to achieve a better tectonic knowledge of the Ceará Central Domain, specially in the individualization metabasic rocks (eclogite and retrograde-eclogite) that properly respond to airborne geophysical. The lineaments from the eastern side of the Santa Quitéria magmatic arc might be an indicative of a crustal boundary associated with the late stages of the Brasiliano collage.

REGIONAL GEOLOGIC SETTING

The Borborema Province of northeast Brazil (Almeida et al., 1981) is a ca. 450,000 km^2 Brasiliano orogenic belt that formed as a result of convergence of the Amazonian, West African-São Luis and São Francisco Cratons during the assembly of West Gondwana around 600 Ma (Brito Neves & Cordani, 1991). This province is part of a larger Pan-Gondwana belt that extends farther south as the Brasília Belt and can be traced into Central Africa by means of lithologic correlations and a series of major shear zones (Caby, 1989; Trompette, 1994).

The Ceará Central Domain (CCD) is the most extensive geotectonic unit of the Borborema Province northern portion, located north of the Patos Lineament. It is limited to the NW by the Transbrasiliano Lineament, to the SE by the Senador Pompeu shear zone (SPSZ), and to the SW-W by the Parnaíba Basin sediments (Fig. 1).

According to Arthaud (2007), the Precambrian terrains of the Ceará Central domain comprise:

(i) basement complex of Archaean to Palaeoproterozoic age, represented by the Tróia massif, is constituted by orthogneisses, gneisses, granodiorites and tonalites, and is mostly limited by shear zones (Caby & Arthaud, 1986). The Tróia massif was dated conventional U-Pb zircon ages at c. 2.7–2.8 Ga (Fetter, 1999) and a SHRIMP U-Pb age of 3.27 Ga, interpreted as crystallization age (Silva et al., 2002) for zircon grains from a meta-tonalite.

(ii) cover of metasedimentary rocks deformed and metamorphosed during the Brasiliano collision: the Ceará Group encompasses most of the metasedimentary cover exposed within the Ceará Central domain. This group comprises a thick and extensive sequence of essentially pelite to semipelite and other terrigenous metasedimentary rocks

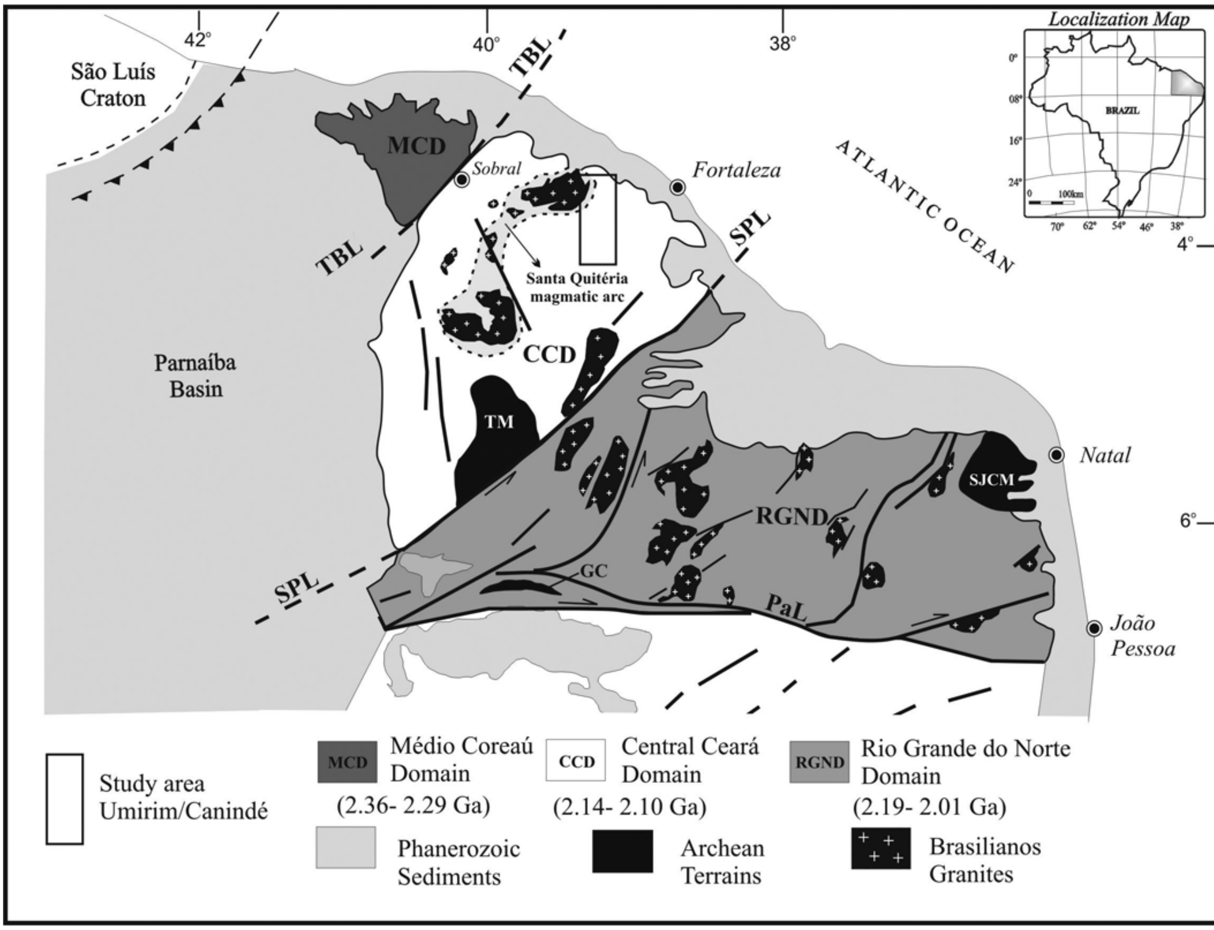

Figure 1 – Geologic sketch of the Borborema Province northern portion and Patos lineament surroundings. SJCM – São José Campestre Massif, TM – Tróia Massif, TBL – Transbrasiliano Lineament, SPL – Senador Pompeu Lineament; PaL – Patos Lineament, GC – Granjeiro Complex. (Source: Santos et al., 2008 – modified).

of greywacke-type. The group also encompasses thick layers of quartzite, marbles and calc-silicate rocks commonly associated with metabasic rocks. The low-angle foliation formed during the early stage of nappe stacking and associated regional metamorphism generally culminated in high-temperature amphibolite facies (Arthaud et al., 2008). Early metamorphic conditions of high-pressure affinity are indicated in some aluminous metapelites by the occurrence of almandine-kyanite-white mica-rutile assemblages that were thoroughly overprinted by sillimanite-biotite-plagioclase assemblages accompagned by anatexis and culminating locally in the granulite facies. Several occurrences of retrograde eclogites were described (Castro, 2004; Garcia & Arthaud, 2004).

(iii) Santa Quitéria magmatic arc: is a large anatectic/igneous complex with a thin, low-angle, basal metasedimentary belt including high temperature mylonites. The plutonic rocks display a ubiquitous syn- to late-magmatic deformation that was coeval with the injection of younger, less deformed magmas. Large volumes of magma were intruded in the form of veins, layers, sheets and plutons. They range in composition from mafic diorite to tonalite to granodiorite and granite (Arthaud et al., 2008). Initially interpreted as an allochthonous unit of possible Archaean age (Caby & Arthaud, 1986), the Tamboril-Santa Quitéria Complex is in fact of Neoproterozoic age, as shown by several Sm-Nd model ages with ε_{Nd} (600) vary between –3 and +3 and U-Pb zircon ages of granitoid rocks of the complex vary between ca. 660 and 614 Ma (Fetter et al., 2003; Castro, 2004). Based on petrographic and isotopic data, Fetter et al. (2003) interpreted the complex as a continental-margin magmatic arc emplaced during the Brasiliano collision.

(iv) Complex Neoproterozoic granites: The Borborema Province is characterized by important granite plutonism related to the Brasiliano Orogeny (Ferreira et al., 1995). Most of the early-collision granites present U-Pb zircon crystallization ages in the 630-620 Ma interval. However, the oldest one so far dated in the magmatic arc is ca. 660 Ma (Brito Neves et al., 2003) and recently Ordovician post-orogenic granites (470-460 Ma) were described (Castro, 2004; Teixeira, 2005).

(v) late-orogenic molasse deposits: several ductile shear zones remained active under shallow crust conditions up to the Cambrian-Ordovician. Their activity controlled the sedimentation in small transtensional-type molasse basins (Arthaud, 2007). Parente et al. (2004) estimate the 560 and 440 Ma interval for the sedimentation of the two depositional sequences in the Jaibaras basin, controlled by the Transbrasiliano lineament.

LOCAL GEOLOGIC SETTING

This paper focuses on the airborne geophysical and geological data of an area located in the north portion of Ceará state. This area encompasses Neoproterozoic supracrustal rocks from the Canindé and Independência units as well as rocks assemblages from the Santa Quitéria magmatic arc.

The Figure 2 shows at a smaller scale (1:500,000) the geologic context of the study area. The Neoproterozoic supracrustal sequence, represented by the Ceará Group (Cavalcante et al., 2003), is characterized by the aluminous supracrustal rocks (mica schists and paragneisses) of the Independência unit, and the gneisses, marbles, calc-silicate rocks, metagabbros, amphibolites and diorites of the Canindé unit, which are widely distributed in the area. The Santa Quitéria magmatic arc, located NW of the area and representing the Neoproterozoic granitic-migmatitic complex, is mainly formed by migmatites of tonalitic to granitic composition, including Neoproterozoic to Ordovician intrusive granitoids of monzogranitic to syenitic composition (Fetter, 1999).

The framework of the area is represented by N-NE-trending lineaments, interpreted as dextral shear zones (Paramoti shear zone), and thrust faults of E-SE transport direction, bordering the Santa Quitéria magmatic arc, and of W-NW on transport direction on the Independência unit metasediments in the SE sector of the area.

THE NATURE OF THE AIRBORNE GEOPHYSICAL DATA

The airborne geophysical data base were made available by the Research and Mineral Resources Company (CPRM) for the Georeferenced Information Processing Laboratory (LAPIG) of the Geosciences Institute (IG) of the State University of Campinas (UNICAMP). The information was provided as XYZ digital files, where X and Y correspond to UTM coordinates (*Datum* Córrego Alegre – Zone 24S) and Z to the magnetometric (nT) and gamma-spectrometry (cps) measurements.

The airborne geophysical data processed in this work were acquired during the development of Itatira Project (CPRM, 1977) in the central region of Ceará (Fig. 3). A total of 80,000 km were surveyed at a flight height of 150 $\pm$ 15 m, controlled by radar-altimeter. The spacings between the N-S flight lines and the perpendicular (E-W) control lines were respectively 500 m and 20 km. The total surveyed area was approximately 38,000 km^2.

Islander aircrafts equipped with GEOMETRICS proton magnetometer, model G-803, and EXPLORANIUM gamma-spectrometer, model DIGRS-3001, were used in the airborne geophysical surveys. The radiometric data were obtained in counts per second (cps) and the magnetic data in nanoteslas (nT), reduced from the 1975 IGRF. The navigation was controlled visually, using flight maps resulting from semicontrolled 1:50,000 aeromosaics, and the checks after the flight were carried out by means of the analysis of the products from the scanning camera (CPRM, 1977).

The remote sensor data come from multispectral orbital Landsat-7/Enhanced Thematic Mapper plus (ETM+) scenes (orbit WRS 217, point 63), and the data from the digital elevation model generated by the "Shuttle Radar Topography Mission" (SRTM).

PROCESSING METHODS

The methods adopted in this work were based on Silva et al. (2003) and Blum et al. (2003). During the airborne geophysical data processing several tests were carried out, aiming at the study of the interpolation algorithms in a regular net, and microlevelling (Minty, 1991) in order to achieve a better data quality. After this step, several linear transformations were applied mainly to the magnetic data (filters, derivatives, analytic signal, and others) that allowed a better understanding of the distribution and nature of the magnetic sources.

The steps of aerogamma-spectometric and aeromagnetometric data processing are summarized in Figures 4 and 5. For the magnetometric data, anomalous magnetic field maps were generated, from which resulted the following products: the analytic signal amplitude-ASA (Roest et al., 1992; Debeglia & Corpel, 1997) and the three derivatives, one vertical (Dz) and two horizontal (Dx and Dy), as well as the total horizontal gradient amplitude-HGA (Milligan & Gunn, 1997). For the radiometric data, grids representing potassium (K), thorium (eTh), uranium

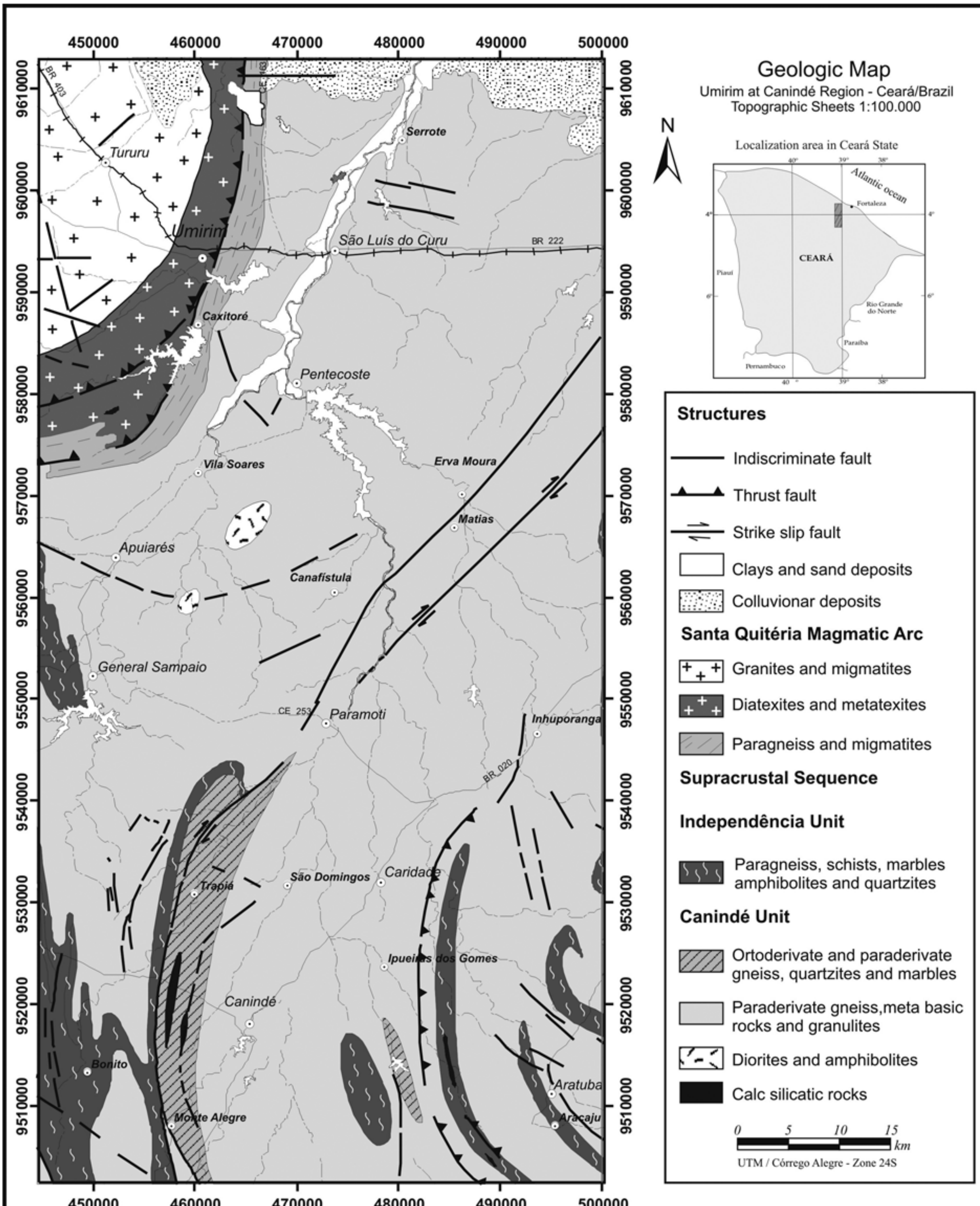

Figure 2 – Geologic-structural map of the Umirim and Canindé regions (1:500,000 scale – modified after Cavalcante et al., 2003).

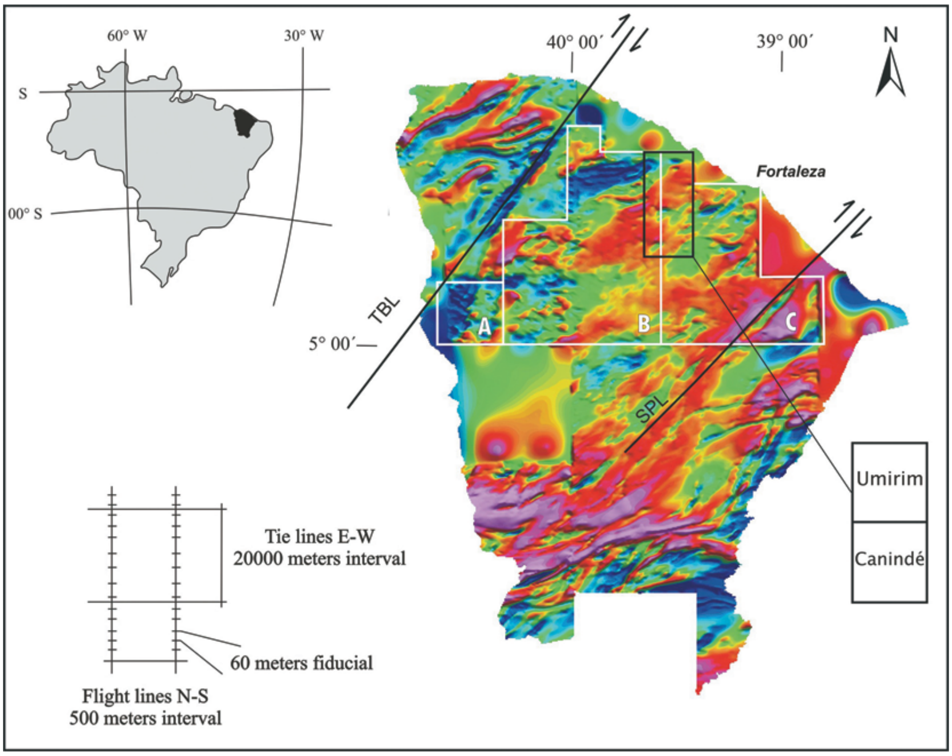

Figure 3 – Location of the Itatira Project, subdivided in three areas (A, B and C); the detail shows the specifications of the profiles and the investigated area.

(eU) channels and the total count (TC) were generated, as well as the false RGB and CMY color compositions and the integration with the Digital Terrain Model (SRTM). The false RGB and CMY color compositions were also integrated with the first vertical derivative of the anomalous magnetic field.

The method applied to the radiometric data processing was similar to that for the magnetic data, except for the interpolation. Despite the good representation of the magnetic data by the bidirectional method, this was not the case for the gamma-spectrometric data. The interpolation method that best represented these data was the minimum curvature. After interpolation, the data were microleveled with the parameters from the magnetic data.

INTEGRATION AND INTERPRETATION OF THE DATA

Magnetic lineaments

The magnetic lineaments were extracted mainly from the horizontal derivative (x, y) and the first vertical derivative (z) images together with the total horizontal gradient amplitude (Fig. 6). These images enhance magnetic lineaments that are not clearly visible in the anomalous magnetic field and analytic signal amplitude images.

NE-SW-trending lineaments coincide with the Paramoti shear zone transcurrent system and Mesozoic basic dikes. In the NW portion of the image, the main magnetic domain is represented by crystalline rocks of the Santa Quitéria magmatic arc. The evident magnetic contact coincides with the thrust fault that marks the tectonic contact between the arc and the supracrustal rocks (Fig. 6).

Magnetic domains

Four main magnetic domains were individualized on the basis of the analytic signal amplitude image (Fig. 7).

The low value zones (0.0042-0.0003 nT/m) are disseminated in the northern (São Luiz do Curu municipality surroundings) and southern (Canindé municipality) sectors. They correspond to the Ceará Complex rocks, Canindé unit, represented by (sillimanite-, kyanite-, garnet-rich) paragneisses, orthogneisses, quartzite lenses, meta-limestones and calc-silicate rocks.

In general, the average values (0.0092–0.0049 nT/m) occur in the contact with low magnetic gradient zones and are mostly related to arkosean quartzites, meta-limestones, mica schists and aluminous paragneisses of the Independência unit (Aratuba and General Sampaio surroundings). The medium to high value

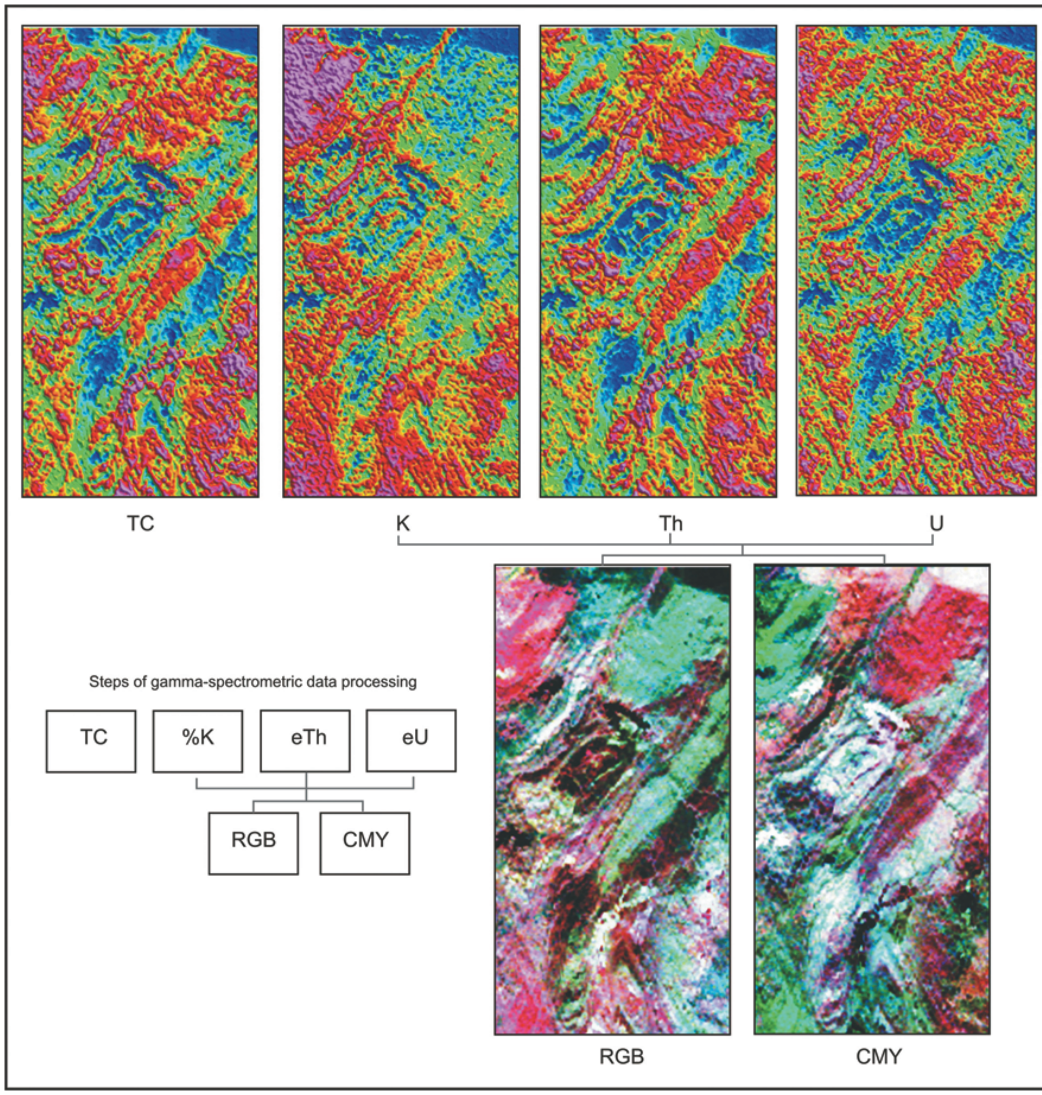

Figure 4 – Steps of gamma-spectrometric data processing generated for this work. TC – total count (μR/h), K – potassium channel (%), U – uranium channel (ppm), Th – thorium channel (ppm), RGB – false RGB color composition, colored with primary additive colors (Red, Green, Blue), CMY – false CMY color composition, colored with secondary colors (Cyan, Magenta, Yellow).

zones (0.035–0.0098 nT/m) are mainly located in the northwestern sector (Tururu, Umirim) and in the center of the area (Pentecoste, Apuiarés and Paramoti) as circular and elongated shapes. These zones are mainly associated with calc-silicate rocks, amphibolites, acid orthogneisses, metagabbros, granodiorites and mafic granulites.

The high value zones (0.6045–0.0422 nT/m) are restricted to the inner part of the medium-high value zones that occur as shapeless circular features. In the northwestern sector of the area, these zones are associated with Santa Quitéria magmatic arc rocks (magnetite-, ilmenite-, biotite- and hornblende-rich granitoids and migmatites). In the central sector (south of Pentecoste), they are associated with (magnetite-, pyroxenes-, and amphibole-rich) granodiorites and metatexites, calc-silicate rocks and mafic granulites (retrograde eclogites) (plagioclase, garnets, amphiboles, pyroxenes and quartz).

Interpretation of the radiometric data

The interpretation of the radiometric data allowed delimit and recognize the differences between faciologic variations of the Santa Quitéria magmatic arc rocks, as well as the contact with the Neoproterozoic supracrustal rocks that occur at a large scale in the mapped area.

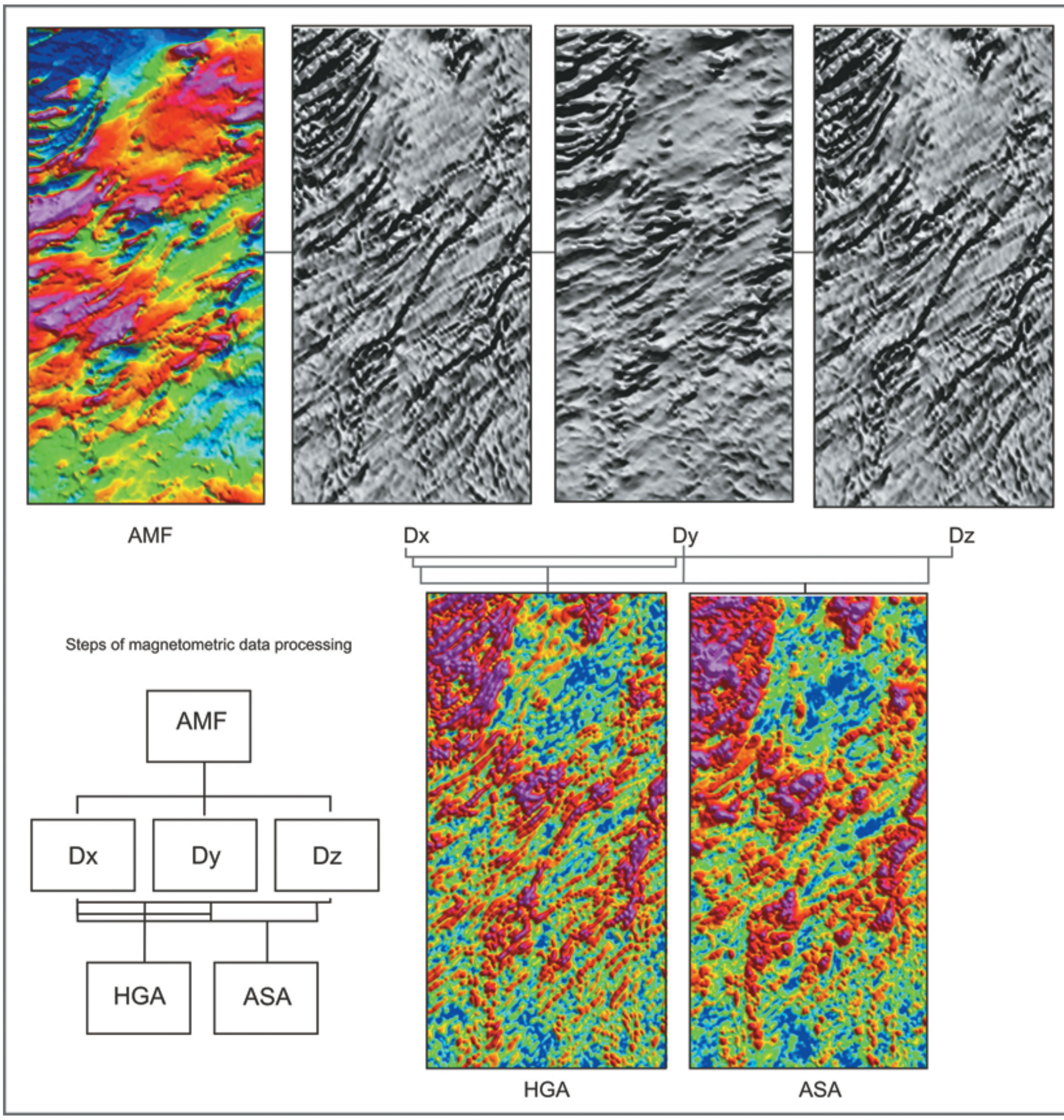

Figure 5 – Steps of magnetometric data processing. False-color maps of the AMF – anomalous magnetic field (nT = nanoTesla); Dx and Dy – first horizontal derivate (nT/m); Dz – first anomalous magnetic field vertical derivative (nT/m); HGA – total horizontal gradient amplitude (nT/m); and ASA – analytic signal amplitude (nT/m).

In this interpretation images were used, which correspond to three individual (K:Th:U) channels, total count (TC) and ternary compositions (RGB, CMY). Therefore, the granitoids and kindred rocks of the Santa Quitéria magmatic arc, situated in the northwestern sector of the area, are characterized by high gamma-spectrometric values when the RGB image is analyzed, being clear the major K contribution. This is corroborated by the geochemical data obtained for a high- to medium-K calc-alkaline suite in this unit. A low Th contribution (blue and greenish tints) are also observed, which result from less evolved rocks, such as amphibolitic portions and more mafic granitoids (gabbros, diorites and tonalites). Chemically this relation is also attested by metabasic rocks that correspond to (N-MORB to T-MORB) low-K tholeiitic basalts (Santos et al., 2008). In the SW sector, the strong K contribution does not indicate the presence of granitic rocks as observed in the NW sector, but of arkosean quartzites, aluminous schists and biotite- and K-feldspar-bearing migmatites.

The Neoproterozoic supracrustal rocks of the Ceará Group (Canindé and Independência units) were characterized by high Th and U and low to intermediate K values. In the ternary RGB image

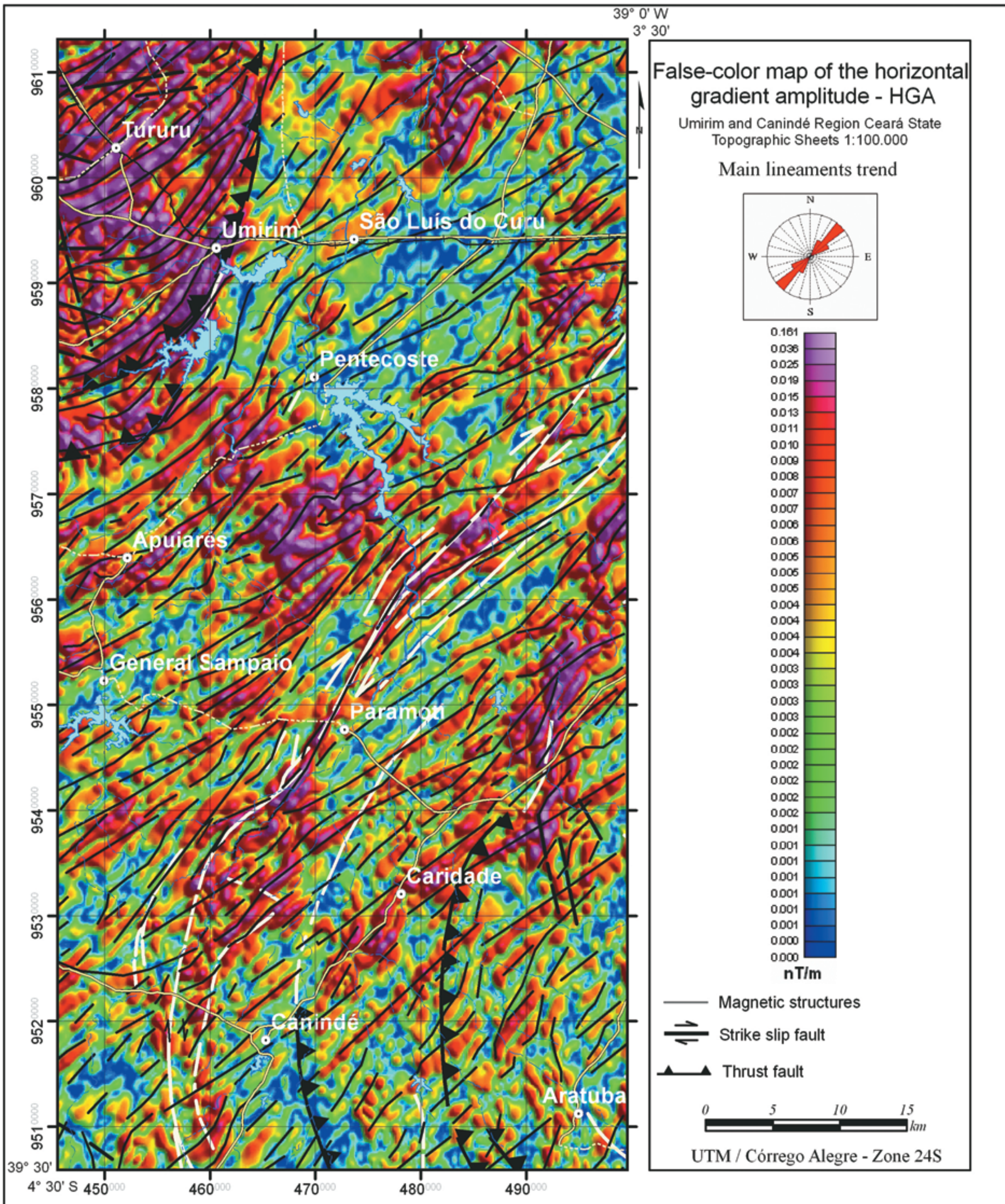

Figure 6 – False-color map of the total horizontal gradient amplitude (HGA), showing the magnetic lineaments and main shear zones.

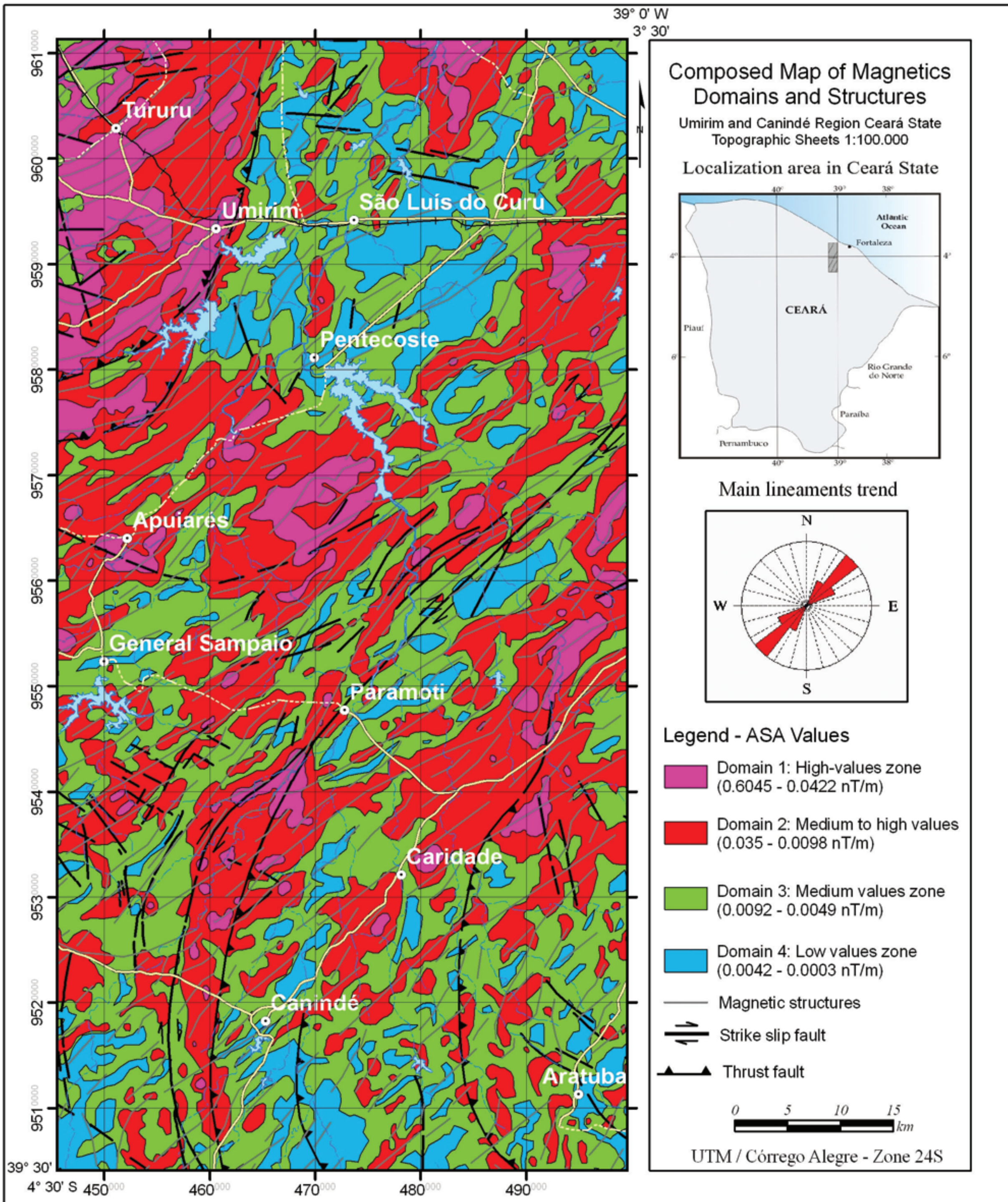

Figure 7 – Main magnetic domains and magnetic lineaments individualized from the analytic signal amplitude (ASA) and total horizontal gradient amplitude (HGA).

(Fig. 8), these rocks are represented in blue and green and are associated with paraderived aluminous gneissic rocks (sillimanite-, kyanite-, cordierite-, plagioclase-, garnet- and quartz- rich) and with amphibole-bearing orthoderived migmatites. The anomalies situated in the central region close to the Pentecoste municipality correspond to low values of the three radioelements represented by black and brown in the RGB image. These anomalies are produced by metabasic rocks (garnet amphibolites, calc-silicate rocks, retrograde eclogites, metagabbros and melanocratic migmatites) containing amphibole (hornblende) and clinopyroxenes (diopside, omphacite pseudomorphs).

In the SW sector a strong U contribution is detected from metasediments that support the Guaramiranga ridge in the Aratuba municipality surroundings. These are whitish to yellow fine muscovite-rich quartzites, gneisses-migmatites and metapelites. They are represented in blue in the ternary RGB image.

In the SW sector, the metasediments of the Bonito sequence are represented by garnet-biotite-muscovite gneiss, quartzofeldspatic (arkosean) gneiss, and subordinate migmatites (metatexites). The rocks from this sequence present high counts for the K and U channels (magenta) and medium and low Th counts. In some regions, K counts are much higher, resultant from the quartzites of arkosean composition.

RESULT FROM THE DATA INTEGRATION

The final product from the data integration is the geologic map for the Umirim and Canindé 1:100,000 sheets (Fig. 9). Two major tectonic domains were individualized in this map: the Santa Quitéria magmatic arc – AMSQ and the surrounding para- and orthoderived supracrustal sequences. Four lithologic types were identified in the arc: **Np_1:** anatectic nuclei; **Np_2:** orthoderived migmatites; **Np_3:** porphyritic gneissic granites; **Np_4:** Caxitoré Unit granodioritic gneisses. The representation of the supracrustal sequence was organized in paraderived sequences (**Ccp**), divided in six subunits, and orthoderived sequences (**Cco**), divided in eight subunits. Eluvial-colluvial covers (**Co**), alluvia (**Al**) and basic dikes (**Db**) were also mapped in the airborne geophysical products.

In general, the supracrustal sequence is characterized by the high contribution from the U and Th channels and low contribution from the K channel. Radiometric anomalies with low counts in the three channels are striking features associated with amphibole- and pyroxene-rich mafic rocks. The main anomaly with such characteristics is found in the central region, south of Pentecoste. These are the Amphibolitic Migmatites and Metaultramafics (Cco3) and Migmatitic hornblende gneisses, mafic granulites (Cco4) subunits, oriented according to the regional trend and composed of mafic rocks/metaultramafic and amphibolitic rocks, standing out as basic and ultrabasic rock belts emplaced as lenses in gneisses and migmatites. These rocks responded to magnetometric measures with positive anomalies and high magnetic susceptibility values.

The Cco4 sequence is petrographically characterized by textures and mineral assemblages typical of retrograde eclogites, high-pressure mafic granulites and high amphibolite-facies garnet amphibolites (Figs. 10A and 10B). The retrograde eclogites are composed of amphibole-hornblende (∼15-20%), clinopyroxene-diopside (∼10%), garnet (∼20-25%), plagioclase (15-20%), quartz (∼5%), rutile, apatite, ilmenite, titanite, zircon and carbonate. Opaque minerals are frequent accessories (∼5-10%). It is common to find the hornblende + plagioclase + garnet association showing symplectitic intergrowth (Fig. 10C). Garnet is poikiloblastic, xenoblastic and corroded. In general decompression is evidenced by the presence of incomplete coronas of quartz and plagioclase surrounding garnet (Fig. 10D). Drop-shaped quartz inclusions are frequent and more rarely blue-greenish pseudomorphs (omphacite).

The migmatitic hornblende gneisses follow the same NE-SW regional trend, and usually crop out as plates or less frequently blocks. They are gray to dark gray, medium- to coarse-grained, and show granoblastic texture. The palaeosome is in general the most abundant portion in these rocks and is constituted by hornblende, biotite, epidote, titanite, apatite, zircon, ilmenite and magnetite, whereas the neosome is basically composed by quartz, plagioclase and microcline.

DISCUSSIONS AND CONCLUSIONS

Considering the geotectonic scenario presented, the characterization of radiometric anomalies (low K, Th and U counts) and a strong magnetometric anomaly may reflect high magnetic susceptibility values individualized in the study area resulted in an important guide to delimit amphibole- and pyroxene-rich mafic rocks. The most striking anomaly is found in the central region, south of Pentecoste, constituting the Cco3 and Cco4 subunits. Microtextural features such as hornblende/clinopyroxene and plagioclase symplectites, garnet surrounded by plagioclase and clinopyroxene, and omphacite pseudomorphs, attest for the high-pressure conditions that affected these rocks. It is possible that these are remnants of an oceanic crust involved in a subduction process with west-northwestward polarity. However, the data here

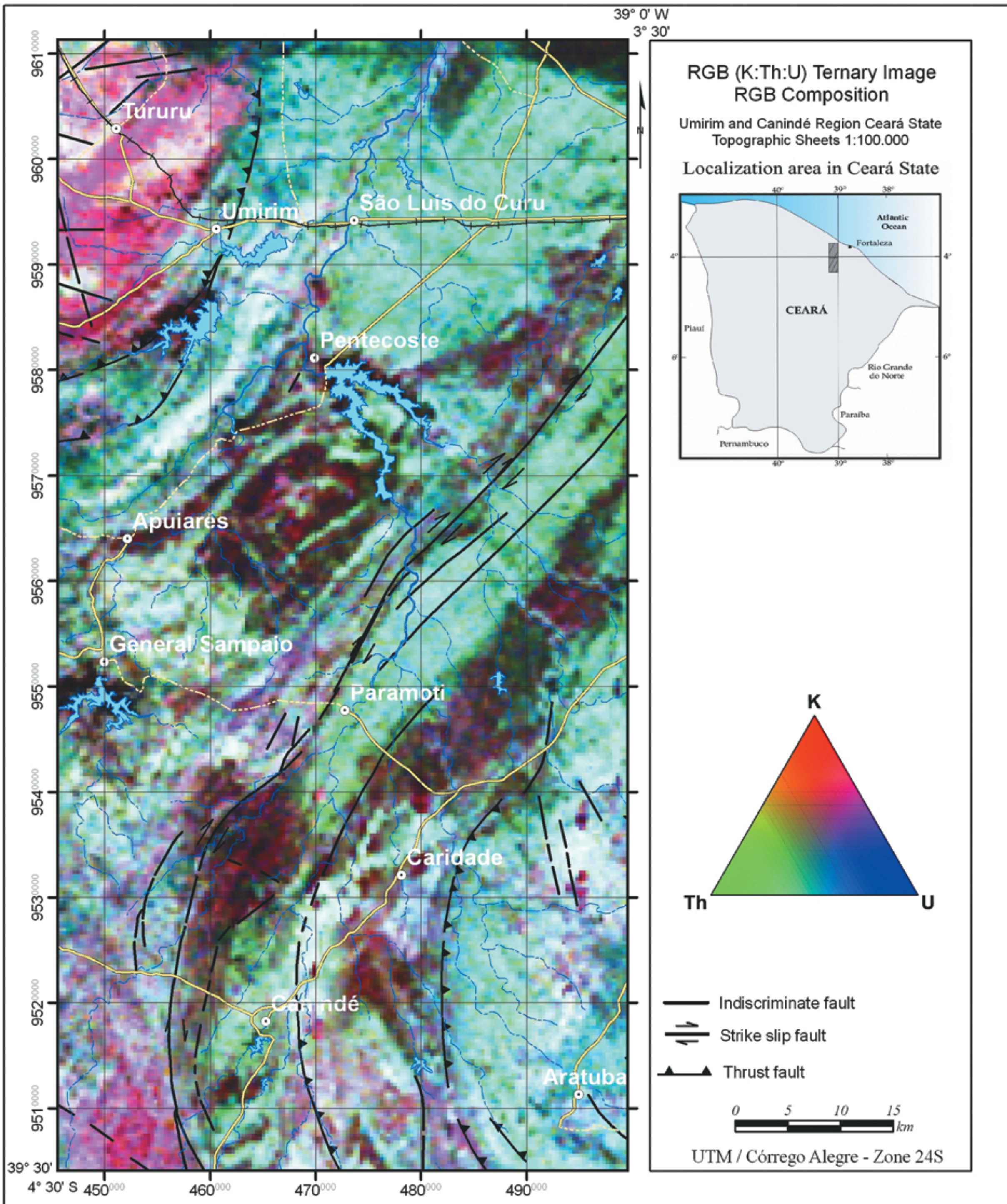

Figure 8 – Radiometric ternary map (Red: K; Green: Th; Blue: U).

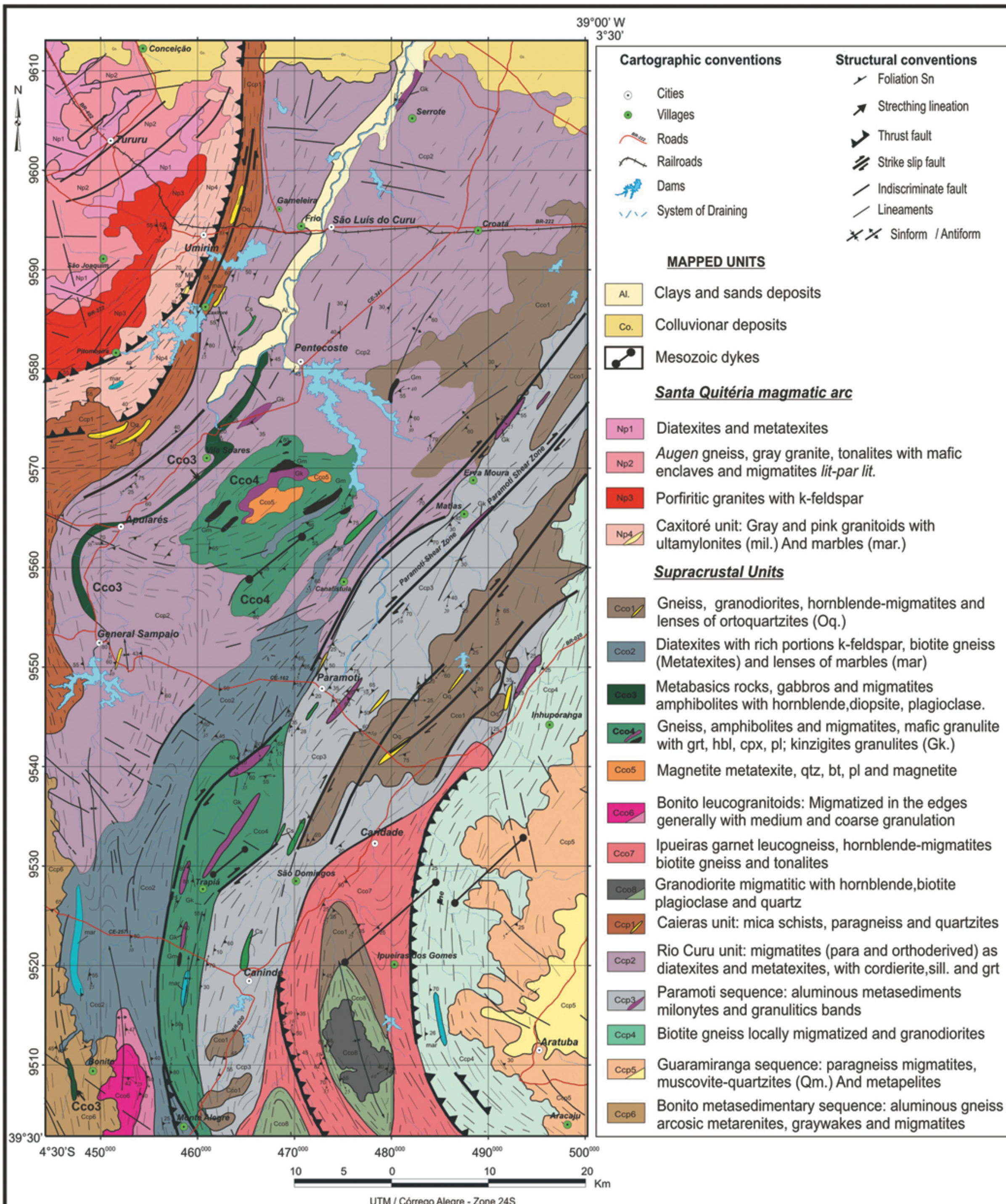

Figure 9 – 1:100,000 Geological map of the Umirim and Canindé regions – CE (modified after Amaral, 2007).

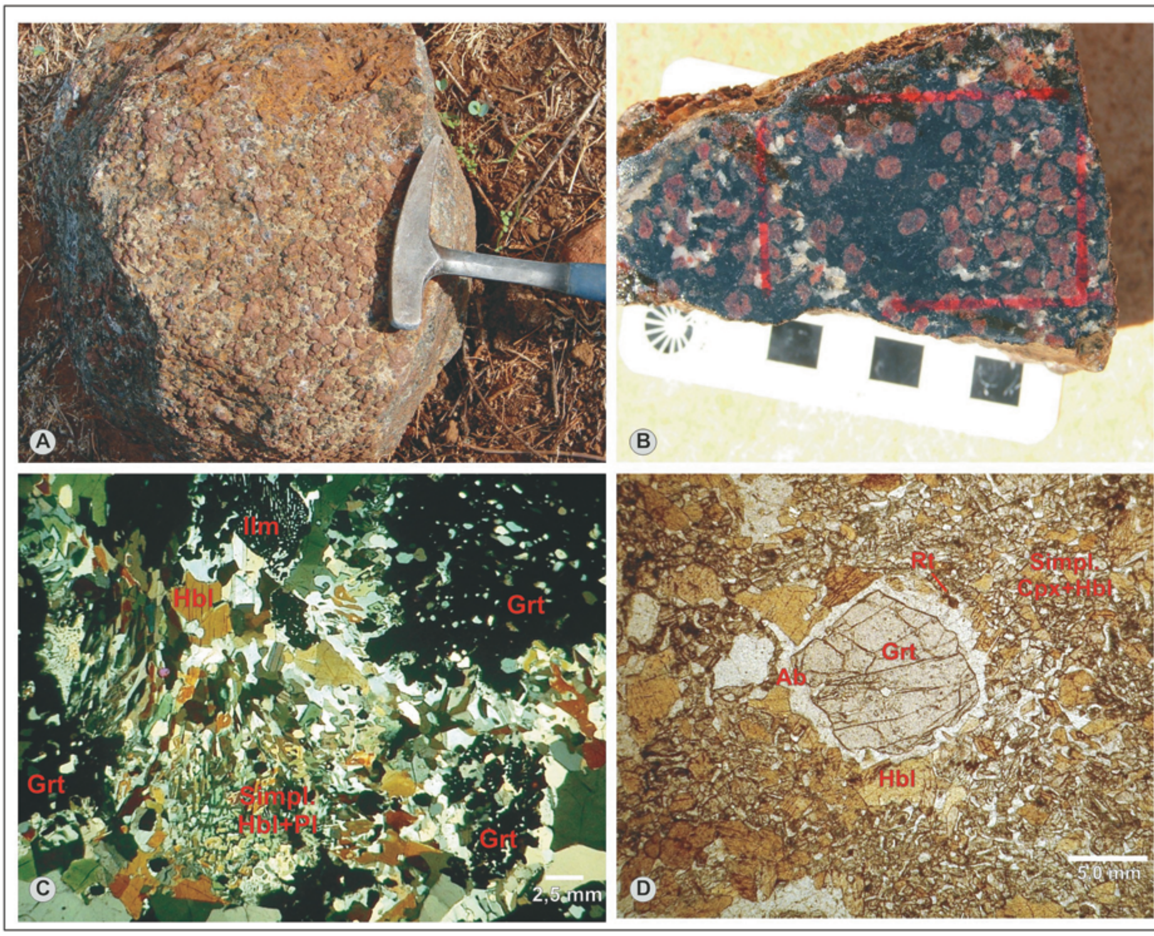

Figure 10 – A) Mafic granulite block, with garnet, clinopyroxene, feldspar and amphiboles; B) Detail of retrograde eclogites with garnets, diopside, plagioclase and hornblende (sample WT7-221); C) Microphotography showing symplectitic textures of plagioclase/hornblende and garnet, plagioclase, quartz inclusion trapped in garnet, rutile, titanite and ilmenite (objective 2.5×), sample WT7-176; D) Microphotography (5×) of garnet with plagioclase and clinopyroxene corona texture evidencing decompression of retrograde eclogites.

presented are still insufficient to characterize these rocks in detail.

On the other hand, it is important to stress out the excellent contribution of airborne geophysical in conjunction with field data to delimit the radiometric signatures of mafic rocks and to individualize the 18 informal mapping subunits. The products derived from magnetometry coupled with (SRTM) digital terrain model images were excellent tools that helped characterize structures such as Paramoti, Umirim and Ipueiras shear zones, faults, dikes and folds.

Geothermobarometric analyses of mafic granulites (retrograde eclogites) will certainly help configure the formation of the Western Gondwana. Further geochemical and (Sm-Nd) geochronological studies can more precisely establish the affinity between mafic/ultramafic rocks (garnet-amphibolites, garnet pyroxenites, retrograde eclogites) of the area and those present in the other parts of the Ceará Central Domain, and also in the African part, the Dahomey and Hoggar belts.

The challenge is to determine, in homologous parts of Northwestern Africa, the continuity of the Santa Quitéria magmatic arc and the major structures that record high-pressure events identified in the northern portion of the Borborema Province.

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